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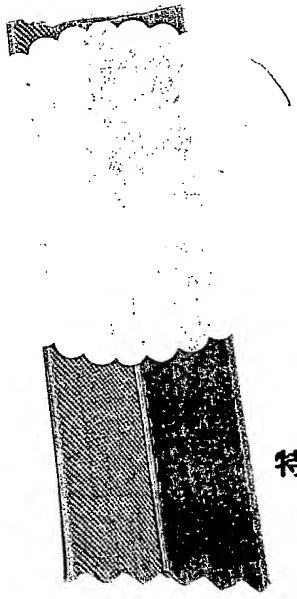

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【発明の名称】　二次電池

【特許請求の範囲】

【請求項１】　正極集電体に正極材料を付着させた正極板と負極集電体に負極材料を付着させた負極板とをセパレータを介して積層した極板群を電解液とともに電池容器内に収容した二次電池において、極板群の少なくとも一側部において何れかの極板の集電体を突出させ、その突出部の先端に自身によって形成した平坦部に集電板を接合したことを特徴とする二次電池。

【請求項２】　正極板と負極板をセパレータを介して渦巻き状に巻回し、その両端に両極板の集電体をそれぞれ突出させた極板群を設け、極板群の端部を巻回軸芯方向に押圧して平坦部を形成したことを特徴とする請求項１記載の二次電池。

【請求項３】　平坦部に集電板を当接配置し、周方向複数箇所を放射方向にレーザ溶接したことを特徴とする請求項２記載の二次電池。

【請求項４】　集電板に、集電体の突出部に向けて突出する突条部を突設し、突条部を押圧させることにより集電体の平坦部を形成すると共に、突条部で集電体と集電板を溶接したことを特徴とする請求項２～３の何れかに記載の二次電池。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】

本発明は二次電池に関し、特に正極集電体に正極材料を付着させた正極板と負極集電体に負極材料を付着させた負極板とをセパレータを介して積層した極板群を電解液とともに電池容器内に収容した二次電池に関するものである。

【０００２】

【従来の技術】

近年、電子機器の小型化、軽量化が急速に進んでおり、その電源としての電池に対しても小型・軽量化と高容量化の要望が高まっている。

【０００３】

その要望に対して、負極活物質として炭素系材料を用い、正極活物質にＬｉＣｏO_2などのリチウム含有遷移金属酸化物を用いたリチウムイオン二次電池が各社で実用化されている。このリチウムイオン二次電池は、負極活物質として金属リチウムあるいはリチウム合金を用いたリチウム二次電池のように充電により負極上へのリチウムの析出が発生しないため、良好なサイクル特性が得られている。そのため、現在電子機器への搭載が進むなど、リチウムイオン二次電池の開発が盛んに行われている。

【０００４】

また、地球環境問題、あるいはエネルギー問題を解決する手段としても、リチウムイオン二次電池の開発が盛んに行われている。地球環境を良好に保全しつつ電力の安定確保を図っていく方策の一つとして負荷の平準化技術の実用化が望まれているが、一般家庭などで小規模に夜間電力を貯蔵する電池電力貯蔵装置を普及させると、大きな負荷平準化効果が期待できる。また、自動車の排気ガスによる大気汚染やCO_2による温暖化防止を図るために、動力源の全部又は一部を二次電池によって得るようにした電気自動車の普及も望まれている。このため、家庭用の電池電力貯蔵装置や電気自動車の動力源として、単電池容量が１００Ａｈ程度の大型のリチウムイオン二次電池の開発も行われている。

【０００５】

この種のリチウムイオン二次電池の構造は、図５に示すように、正極集電体２１ｂに正極材料２１ａを付着させた正極板２１と、負極集電体２２ｂに負極材料２２ａを付着させた負極板２２とをセパレータ２３を介して渦巻き状に積層した極板群３０を電解液とともに電池缶２５と電池蓋２６とから成る電池容器２４内に収容し、正極集電体２１ｂの適所に一端を接合した正極集電タブ２８の他端を正極端子となる電池蓋２６の内面に接続し、負極集電体２２ｂの適所に一端を接合した負極集電タブ２９の他端を負極端子となる電池缶２５の内底面に接続して構成されている。

【０００６】

【発明が解決しようとする課題】

ところが、上記構成の二次電池では、正極板２１及び負極板２２の１箇所から

集電タブ２８、２９を介して電流を取り出すようにしているので、正極板２１や負極板２２から集電タブ２８、２９までの平均距離が長くまた集電タブ２８、２９の面積も小さいために電気抵抗が大きく、集電効率が悪いために大電流で充放電を行うと温度が上昇して寿命が短くなるという問題があった。

【０００７】

なお、このような問題を解消する手段として、例えば特開平８－１１５７４４号公報には、両極板の集電体をそれぞれ反対側の側部に突出させてその突出部の先端部にそれぞれリード線を配置した状態でセパレータを介して両極板を巻回することにより、両端にリード線と集電体の端縁にて形成された正極端面と負極端面を有する極板群を構成し、これら正極端面と負極端面にそれぞれの端子を接続したものが開示されている。しかし、リード線が必要となるとともに製造工程も複雑になるため、コスト高になるという問題がある。

【０００８】

また、特開平１０－２１９５３号公報には、両極板の集電体をそれぞれ反対側の側部に突出させ、それらの先端部を正極端子及び負極端子に弾性的に圧接させるようにしたものが開示されている。しかし、集電体の先端部を弾性範囲内で鋭角状に曲げ、その弾性復元力で端子に接続しているだけであるため、電気的な接続が不安定で、振動を受けるような使用状態では電池出力の安定性に欠けるという問題がある。

【０００９】

本発明は、上記従来の問題点に鑑み、集電効率が高く、充放電時の温度上昇を小さくでき、かつ安価な構成で安定的に充放電できる二次電池を提供することを目的としている。

【００１０】

【課題を解決するための手段】

本発明の二次電池は、正極集電体に正極材料を付着させた正極板と負極集電体に負極材料を付着させた負極板とをセパレータを介して積層した極板群を電解液とともに電池容器内に収容した二次電池において、極板群の少なくとも一側部において何れかの極板の集電体を突出させ、その突出部の先端に自身によって形成

した平坦部に集電板を接合したものであり、集電体の一側部にて形成された平坦部に集電板が接合されるので集電効率が高く、充放電時の温度上昇を小さくでき、かつ集電体自身で平坦部を形成しているので安価に構成できるとともにその平坦部に集電板を接合しているので振動等に対しても安定した構造となり、安定的に充放電できる。

【００１１】

また、正極板と負極板をセパレータを介して渦巻き状に巻回し、その両端に両極板の集電体をそれぞれ突出させた極板群を設け、極板群の端部を巻回軸芯方向に押圧して平坦部を形成すると、集電板を接合するための集電体の平坦部を押圧によって能率良く形成することができる。

【００１２】

また、平坦部に集電板を当接配置し、周方向複数箇所を放射方向にレーザ溶接すると、集電体の側端縁の多数箇所を集電板に簡単に一体溶着することができ、高い集電効率を作業性良く達成することができる。

【００１３】

また、集電板に、集電体の突出部に向けて突出する突条部を突設し、突条部を押圧させることにより集電体の平坦部を形成すると共に、突条部で集電体と集電板を溶接すると、集電板と平坦部が突条部で確実に接し、集電板と集電体のより確実な接合状態が得られる。

【００１４】

【発明の実施の形態】

以下、本発明の二次電池の一実施形態のリチウムイオン二次電池について、図１～図３を参照して説明する。

【００１５】

図１において、１は正極板、２は負極板で、微多孔ポリエチレンフィルムから成るセパレータ３を介して互いに対向された状態で渦巻き状に巻回されて極板群１０が構成され、この極板群１０が電解液とともに電池容器４内に収納配置されている。電池容器４は負極端子となる円筒容器状の電池缶５と正極端子となる電池蓋６にて構成され、電池缶５の上端開口部内周と電池蓋６の外周との間に介装

された絶縁パッキン７にて相互に絶縁されるとともに電池容器４が密閉されている。なお、極板群１０と電池缶５の内周との間にもセパレータ３は介装されている。

【００１６】

正極板１は、正極集電体１ｂの両面に正極材料１ａを塗工して構成されるとともに、その正極集電体１ｂの一側部（図示例では上側部）が正極材料１ａの塗工部より突出されている。また、負極板２は、負極集電体２ｂの両面に負極材料２ａを塗工して構成されるとともに、その負極集電体２ｂの他側部（図示例では下側部）が負極材料２ａの塗工部より突出されている。セパレータ３は正極板１及び負極板２の塗工部の両側縁よりも外側に突出されている。

【００１７】

そして、正極集電体１ｂのセパレータ３より突出した部分を押圧することによって正極集電体１ｂの突出部を塑性変形させて平坦部１１が形成され、この平坦部１１に正極集電板８が接合されている。同様に、負極集電体２ｂのセパレータ３より突出した部分を押圧することによって負極集電体２ｂの突出部を塑性変形させて平坦部１２が形成され、この平坦部１２に負極集電板９が接合されている。これら正極集電板８及び負極集電板９はそれぞれ電池蓋６と電池缶５に接続されている。８ａ、９ａは、集電板８、９を電池蓋６の内面及び電池缶５の内底面に接合するためその外周から延出された接続片である。

【００１８】

正極板１、負極板２、及び電解液について詳細に説明すると、正極集電体１ｂはアルミ箔などから成り、その両面に正極活物質と結着剤を含む正極材料１ａを塗工して正極板１が構成されており、その正極活物質としては、$LiCoO_2$、$LiMn_2O_4$、$LiNiO_2$、若しくはこれらＣｏ、Ｍｎ、Ｎｉの一部を他の遷移金属で置換したもの、あるいはそれ以外のリチウム含有遷移金属酸化物が用いられる。特に、地球上に豊富に存在し、低価格である$LiMn_2O_4$などのＭｎ系リチウム含有遷移金属酸化物が適している。

【００１９】

負極集電体２ｂは銅箔などから成り、その両面に負極活物質と結着剤を含む負

極材料２ａを塗工して負極板２が構成されており、その負極活物質としては、グラファイト、石油コークス類、炭素繊維、有機高分子焼成物などの炭素質材料を用いるか、リチウムを吸蔵、放出可能な金属、あるいは酸化物、若しくはこれらの複合化材料が用いられる。

【００２０】

また、電解液は、溶質として６フッ化リン酸リチウム（$LiPF_6$）、過塩素酸リチウム（$LiClO_4$）、ホウフッ化リチウム（$LiBF_4$）などのリチウム塩、溶媒としてエチレンカーボネイト（ＥＣ）、プロピレンカーボネイト（ＰＣ）、ジエチレンカーボネイト（ＤＥＣ）、エチレンメチルカーボネイト（ＥＭＣ）などの非水溶媒単独、若しくはそれらの混合溶媒を用い、この溶媒に溶質を０．５ mol/dm^3 ～２ mol/dm^3 の濃度に溶解したものが使用される。

【００２１】

具体例を示すと、正極板１は、電解二酸化マンガン（ＥＭＤ：MnO_2）と炭酸リチウム（Li_2CO_3）とをＬｉ／Ｍｎ＝１／２となるように混合し、８００℃で２０時間大気中で焼成して製造した正極活物質の$LiMn_2O_4$と、導電剤のアセチレンブラックと、結着剤のポリフッ化ビニリデンとを、それぞれ重量比で９２：３：５の割合で混合したものを正極材料１ａとした。なお、正極材料１ａをペースト状に混練するために結着剤としてのポリフッ化ビニリデンはＮメチルピロリドンディスパージョン液を用いた。上記混合比率は固形分としての割合である。この正極材料ペーストを、厚み２０μｍのアルミ箔から成る正極集電体１ｂの両面に一側縁部に幅１０ｍｍの非塗工部を残した状態で塗工し、正極材料層を形成した。正極材料層の両膜厚は同じで、塗工、乾燥後の両膜厚の和は２８０μｍで、正極板１の厚さを３００μｍとした。その後、正極板１の厚みが２００μｍになるように直径３００ｍｍのプレスロールにより圧縮成形した。このとき、正極材料密度は３．０ｇ／ｃｍ^{3}であった。

【００２２】

負極板２は、人造黒鉛と結着剤のスチレンブタジエンゴム（ＳＢＲ）とを重量比９７：３の割合で混合したものを負極材料２ａとした。なお、負極材料２ａをペースト状に混練するために結着剤としてのスチレンブタジエンゴムは水溶性の

ディスパージョン液を用いた。上記混合比率は固形分としての割合である。この負極合剤ペーストを厚み１４μｍの銅箔から成る負極集電体２ｂの両面に一側縁部に幅１０ｍｍの非塗工部を残した状態で塗工し、負極材料層を形成した。その後、負極板２の厚みが１７０μｍになるように直径３００ｍｍのプレスロールにより圧縮成形した。このとき、負極材料密度は１．４ｇ／ｃｍ^3 であった。

【００２３】

電解液は、エチレンカーボネイト（ＥＣ）とジエチレンカーボネイト（ＤＥＣ）を体積比１：１の配合比で混合した混合溶媒に、溶質として６フッ化リン酸リチウム（ＬｉＰＦ$_6$）を１ ｍｏｌ／ｄｍ^3 の濃度に溶解したものを用いた。

【００２４】

このリチウムイオン二次電池の製造に当たっては、上記のようにして作製した正極板１と負極板２をセパレータ３を介して対向させかつそれらの集電体１ｂ、２ｂの突出部を両端に突出させた状態で渦巻き状に巻回して極板群１０を形成し、この極板群１０を、図２に示すように、円筒容器状の成形治具１３内に挿入配置し、成形治具１３の一端開口から押圧具１４にて押圧する。すると、集電体１ｂ、２ｂの突出部が仮想線で示すように径方向内側に向けて略９０°折り曲がるように塑性変形され、平坦部１１、１２が形成される。即ち、正極板１及び負極板２が渦巻き状に巻回されているので、集電体１ｂ、２ｂの突出部が径方向外側には屈折せず、全体が略均等に逐次径方向内側に向けて折り曲げるように塑性変形されることになり、多少の皺を生じさせながらも全体として平坦部１１、１２が形成されることになる。

【００２５】

次いで、平坦部１１、１２を形成した極板群１０を成形治具１３から取り出し、図３に示すように、集電板８、９を平坦部１１、１２に押し付けるように配置して両者を圧接させた状態で、集電板８、９の表面の周方向複数箇所を中心部から外周縁まで放射状にレーザビーム１５を照射することによって集電板８、９と平坦部１１、１２をレーザ溶接する。その後、この集電板８、９を接合した極板群１０を電池缶５内に電解液とともに収容して真空含浸させ、電池蓋６で密閉するとともに、集電板８、９と電池蓋６と電池缶５をそれぞれレーザ溶接等にて接

続する。

【００２６】

以上の構成のリチウムイオン二次電池によれば、正極板１と負極板２をセパレータ３を介して渦巻き状に巻回し、その両端に両極板の集電体１ｂ、２ｂをそれぞれ突出させた極板群１０を設け、極板群１０の両端から突出している各集電体１ｂ、２ｂにて形成された平坦部１１、１２に集電板８、９が接合されているので集電効率が高く、充放電時の温度上昇を小さくできる。しかも、平坦部１１、１２は、集電体１ｂ、２ｂ自身で形成しているので安価に構成できるとともにその平坦部１１、１２に集電板８、９を接合しているので振動等に対しても安定した構造となり、安定的に充放電できる。

【００２７】

また、極板群１０の両端部を巻回軸芯方向に押圧して平坦部１１、１２を形成しているので、集電板８、９を接合するための集電体１ｂ、２ｂの平坦部１１、１２を押圧によって能率良く形成することができる。

【００２８】

また、平坦部１１、１２に向けて集電板８、９を押圧し、圧接させた状態で周方向複数箇所を放射方向にレーザ溶接しているので、集電体１ｂ、２ｂの側端縁の多数箇所を集電板８、９に簡単に一体溶着することができ、高い集電効率を作業性良く達成することができる。

【００２９】

上記実施形態の説明では、集電板８、９として全面が平板状のものを例示したが、図４に示すように、集電板８、９に、極板群１０の集電体１ｂ、２ｂの突出部に向けて突出する突条部１６を放射状に突出形成し、その突条部１６を突出部に食い込むように集電板８、９を押圧し、突出部に平坦部１１、１２を形成した状態で突条部１６に沿ってレーザ溶接するようにしてもよい。

【００３０】

このように集電板８、９に突条部１６を突設し、これを集電体１ｂ、２ｂの突出部に押圧してレーザ溶接すると、集電板８、９と突出部に形成された平坦部１１、１２が突条部１６を介して確実に接し、集電板８、９と集電体１ｂ、２ｂの

より確実な接合状態が得られる。

【００３１】

【発明の効果】

本発明の二次電池によれば、以上の説明から明らかなように、極板群の少なくとも一側部において何れかの極板の集電体を突出させ、その突出部の先端に自身によって平坦部を形成し、集電板を接合したので、集電効率が高く、充放電時の温度上昇を小さくでき、かつ集電体自身で平坦部を形成しているので安価に構成できるとともにその平坦部に集電板を接合しているので振動等に対しても安定した構造となり、安定的に充放電できる。

【００３２】

また、正極板と負極板をセパレータを介して渦巻き状に巻回し、その両端に両極板の集電体をそれぞれ突出させた極板群を設け、極板群の端部を巻回軸芯方向に押圧して平坦部を形成すると、集電板を接合するための集電体の平坦部を押圧によって能率良く形成することができる。

【００３３】

また、平坦部に集電板を当接配置し、周方向複数箇所を放射方向にレーザ溶接すると、集電体の側端縁の多数箇所を集電板に簡単に一体溶着することができ、高い集電効率を作業性良く達成することができる。

【００３４】

また、集電板に、集電体の平坦部に向けて突出する突条部を突設し、突条部を押圧させることにより集電体の平坦部を形成すると共に、突条部で集電体と集電板を溶接すると、集電板と平坦部が突条部で確実に接し、集電板と集電体のより確実な接合状態が得られる。

【図面の簡単な説明】

【図１】

本発明の二次電池の一実施形態の縦断面図である。

【図２】

同実施形態における極板群の集電体の突出部に平坦部を形成する工程の縦断面図である。

【図３】

同実施形態における極板群の集電体の平坦部に集電板を接合する工程の斜視図である。

【図４】

本発明の二次電池の他の実施形態における集電板及びその接合状態を示す斜視図である。

【図５】

従来例の二次電池の縦断面図である。

【符号の説明】

１　正極板

１ａ　正極材料

１ｂ　正極集電体

２　負極板

２ａ　負極材料

２ｂ　負極集電体

３　セパレータ

４　電池容器

８　正極集電板

９　負極集電板

１０　極板群

１１　平坦部

１２　平坦部

１３　成形治具

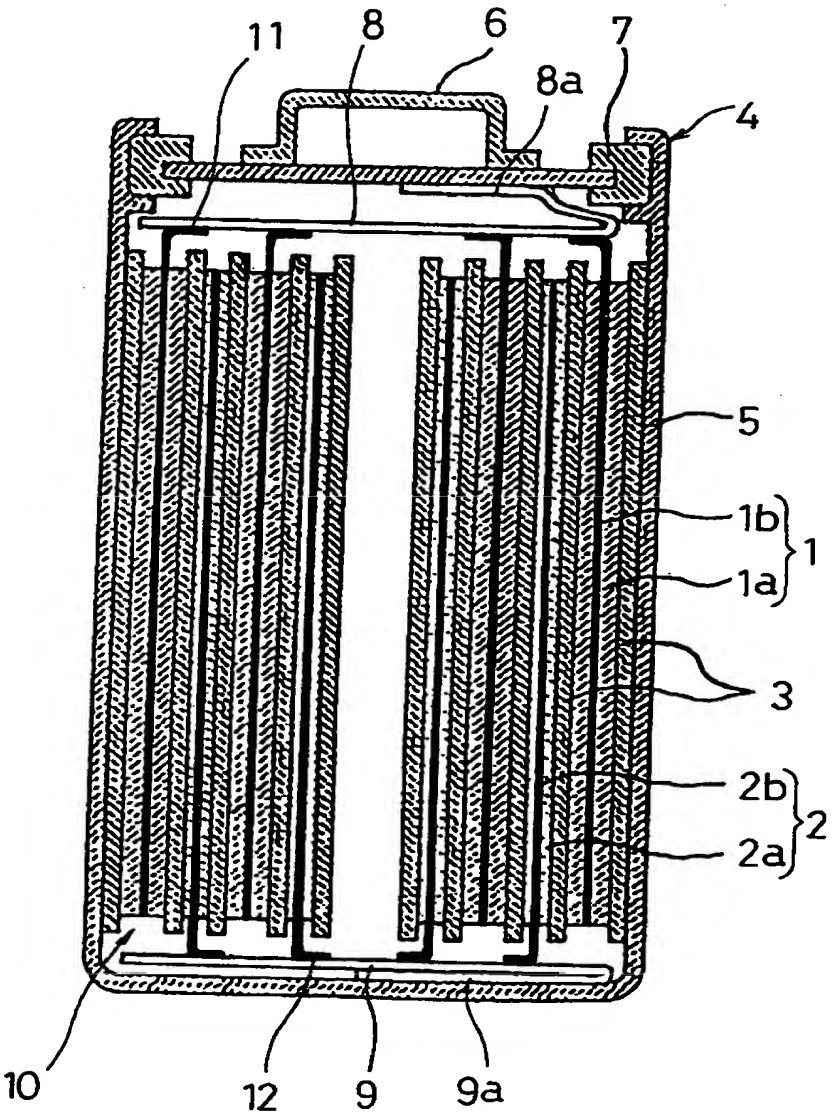
１４　押圧具

１５　レーザービーム

１６　突条部

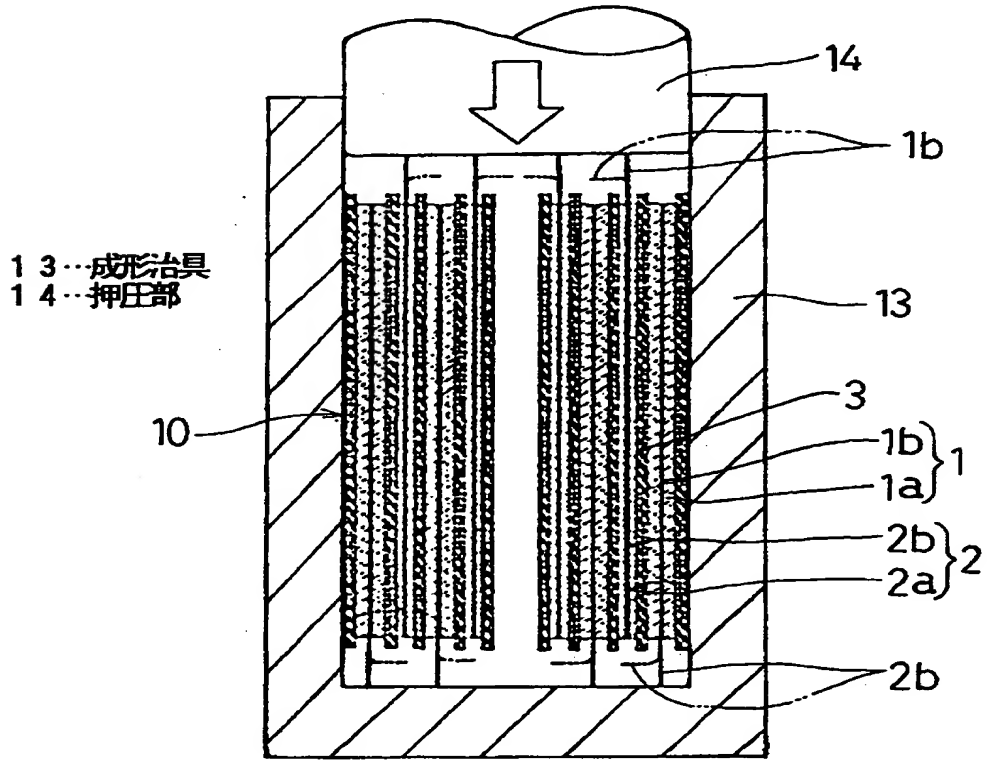
【書類名】　　図面

【図１】

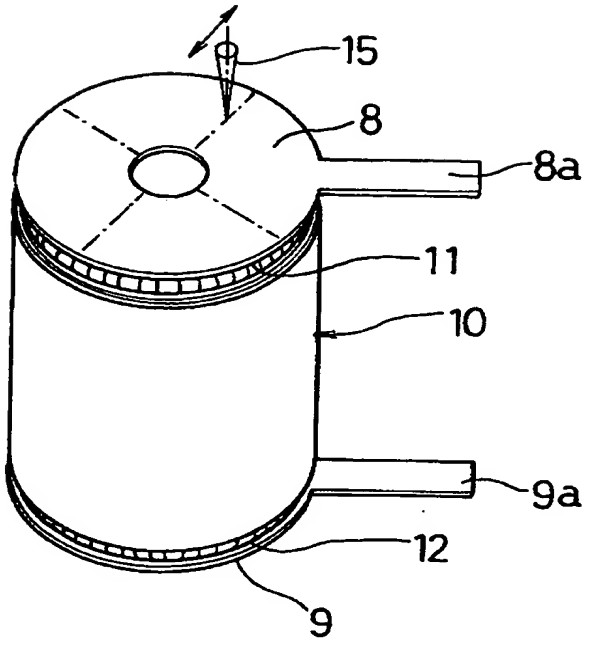


1…正極板
1a…正極材料
1b…正極集電体
2…負極板
2a…負極材料
2b…負極集電体
3…セパレータ
4…電池容器
8…正極集電板
9…負極集電板
10…極板群
11…平坦部
12…平坦部

【図２】

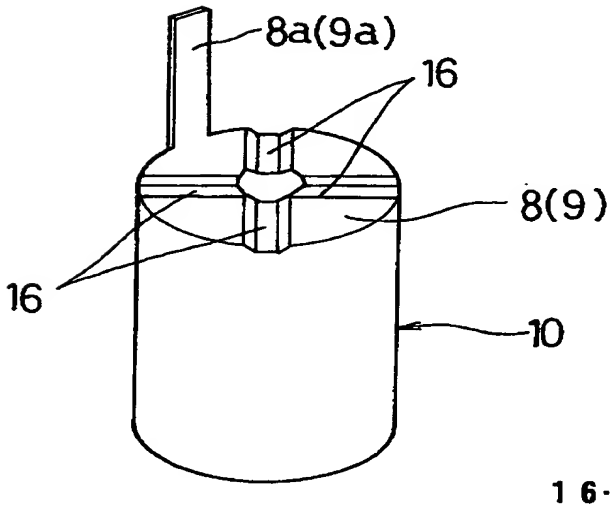


【図３】



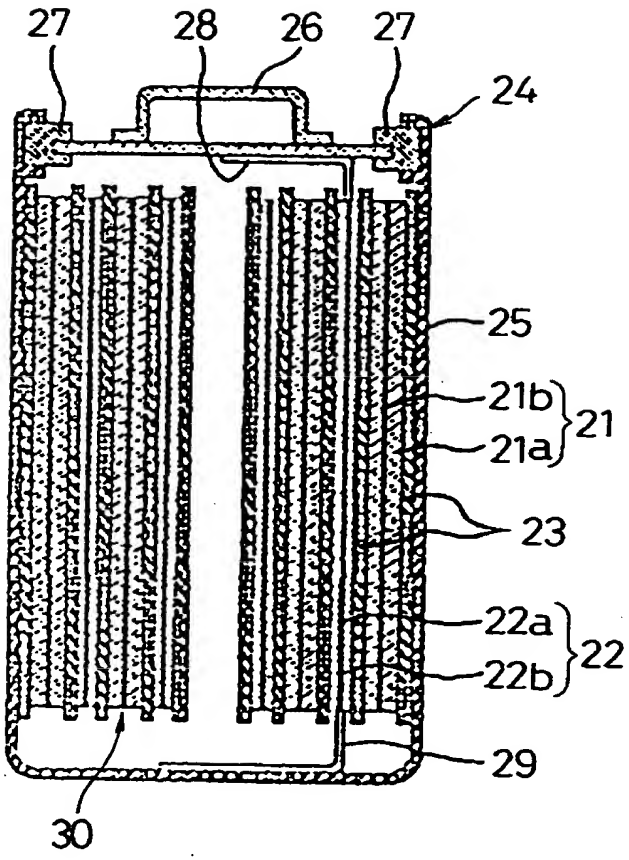
１５…レーザビーム

【図４】



１６…突条部

【図５】



【書類名】　　要約書

【要約】

【課題】　集電効率が高く、充放電時の温度上昇を小さくでき、かつ安価な構成で安定的に充放電できる二次電池を提供する。

【解決手段】　正極集電体１ｂに正極材料１ａを付着させた正極板１と負極集電体２ｂに負極材料２ａを付着させた負極板２とをセパレータ３を介して積層した極板群１０を電解液とともに電池容器４内に収容した二次電池において、極板群１０の両端に極板１、２の集電体１ｂ、２ｂをそれぞれ突出させ、その突出部を押圧して集電体１ｂ、２ｂ自身によって平坦部１１、１２を形成し、この平坦部１１、１２に集電板８、９を接合した。

【選択図】　　図１

出　願　人　履　歴　情　報

識別番号　　〔０００００５８２１〕

１．変更年月日　　１９９０年　８月２８日
［変更理由］　新規登録
住　所　　大阪府門真市大字門真１００６番地
氏　名　　松下電器産業株式会社

#10
10-18-2

ENGLISH TRANSLATION OF

PRIORITY DOCUMENT

JAPANESE PATENT APPLICATION NO. 11-100750

FILED ON 8 APRIL 1999

[DOCUMENT] SPECIFICATION

[TITLE OF THE INVENTION] RECHARGEABLE BATTERY

[SCOPE OF CLAIMS]

[CLAIM 1] A rechargeable battery in which an electrode group obtained by superimposing a positive electrode plate, in which positive electrode material is attached to a positive electrode current collecting element, and a negative electrode plate, in which negative electrode material is attached to a negative electrode current collecting element, with a separator therebetween is accommodated in a battery enclosure together with electrolyte, wherein the current collecting element of one of the electrode plates is made to project on at least one side of the electrode plate group, and current collecting plates are joined to flat sections formed at the tip of this projection by the projection itself.

[CLAIM 2] The rechargeable battery according to claim 1, wherein an electrode plate group is provided in which positive electrode plate and negative electrode plate are wound in spiral fashion with a separator therebetween, with current collecting elements of both electrode plates respectively projecting at both ends thereof, and flat sections are formed by pressing the ends of electrode plate group in the direction of the winding axis core.

[CLAIM 3] The rechargeable battery according to claim 2, wherein current collecting plates are arranged in contact with flat sections, and are laser-welded in the radial direction at a plurality of locations in the circumferential direction.

[CLAIM 4] The rechargeable battery according to claim 2 or 3, wherein ribs are provided that project toward the projections of the current collecting elements on the current collecting plates, and the flat sections of the current collecting elements are formed by pressing ribs thereupon and welding the current collecting elements and the current collecting plates at ribs.

[DETAILED DESCRIPTION OF THE INVENTION]

[0001]

[TECHNICAL FIELD OF THE INVENTION]

The present invention relates to rechargeable batteries, and in particular to rechargeable batteries wherein an electrode plate group obtained by superimposing a positive electrode plate, in which positive electrode material is attached to a positive electrode current collecting element, onto a negative electrode plate, in which negative electrode material is attached to a negative electrode current collecting element, with a separator therebetween, is accommodated in a battery enclosure together with electrolyte.

[0002]

[PRIOR ART]

In recent years, there has been rapid progress in reducing the size and weight of electronic equipment, which has increased demands to reduce the size and weight and increase the capacity of the batteries used as their power sources.

[0003]

To meet these demands, lithium ion rechargeable batteries employing a carbon-based material as the negative electrode active substance and employing a transition metal oxide containing lithium, such as $LiCoO_2$, as the positive electrode active substance have been put into practice by various companies. Lithium rechargeable batteries in which metallic lithium or lithium alloy is employed as the negative electrode active substance are subject to the problem that precipitation of the lithium onto the negative electrode occurs due to charging, but lithium ion rechargeable batteries do not suffer from this problem and so have excellent cycle characteristics. As a result, there has been vigorous development of lithium ion rechargeable batteries and their use in electronic equipment has become more common.

[0004]

There has also been vigorous development of lithium rechargeable batteries as a means of solving global environmental problems or energy problems. As a way of

guaranteeing power stability while maintaining a good global environment, implementation of technology for load equalization is desired; considerable benefits in terms of load equalization could be expected if use of small-scale battery power storage devices capable of storing power during the night could be made common in ordinary households etc. In order to prevent atmospheric pollution by car exhaust gases and global warming due to CO_2, it would also be desirable to extend the use of electric cars in which some or all of the motive power is obtained by rechargeable batteries. Large lithium ion rechargeable batteries with a cell capacity of about 100 Ah are therefore being developed for use as battery power storage devices for domestic use and as power sources for electric cars.

[0005]

The construction of such a lithium ion rechargeable battery is shown in Figure 5. An electrode plate group 30 constituted by superimposing a positive electrode plate 21, in which positive electrode material 21a is attached to a positive electrode current collecting element 21b, and a negative electrode plate 22, in which negative electrode material 22a is attached to a negative electrode current collecting element 22b, wound in spiral fashion with a separator 23 therebetween are accommodated in a battery enclosure 24 comprising battery case 25 and battery cover 26

together with electrolyte; a positive electrode current collecting element tab 28 with one end joined to a suitable location of a positive electrode current collecting element 21b has its other end connected to the inner surface of battery cover 26 constituting the positive electrode terminal, while the negative electrode current collecting element tab 29 with one end joined to a suitable location of negative electrode current collecting element 22b has its other end connected to the inside bottom surface of battery case 25 constituting the negative electrode terminal. Insulating packing 27 is introduced in between the inner circumference of the top end aperture of battery case 25 and the outer circumference of battery cover 26 so as to mutually insulate battery case 25 and battery cover 26 and to seal battery enclosure 24.

[0006]

[PROBLEMS TO BE SOLVED BY THE INVENTION]

However, since, in a rechargeable battery constructed as described above, current was extracted from a single location of a positive electrode plate 21 and negative electrode plate 22 through current collecting tabs 28 and 29, the average distance from positive electrode plate 21 and negative electrode plate 22 to current collecting tabs 28 and 29 was long, and the area of current collecting tabs 28 and 29 was small, so their electrical resistance was large and the

current collecting efficiency was poor. Furthermore, since the current collecting efficiency was poor, there was the problem that charging and discharging with large currents resulted in increased battery temperatures, which shortens the life of the rechargeable battery.

[0007]

As a means of solving this problem, for example Laid-open Japanese Patent publication number H. 8-115744 discloses a constitution of an electrode group comprising a positive electrode end face and negative electrode end face formed at the edge of a current collecting element and leads at both ends, by winding both electrode plates, with a separator therebetween, in a condition in which their respective leads are arranged at the tips of projections thereof, with the current collecting elements of the two electrode plates projecting at side parts on respectively opposite sides, the terminals being connected to this positive electrode end face and negative electrode end face respectively. However, this is subject to the problem of high cost, since leads are required and the manufacturing steps become complicated.

[0008]

Also, Laid-open Japanese patent application number H. 10-21953 discloses an arrangement in which current collecting elements of both electrode plates project at side parts on

respectively opposite sides and their tips make resilient pressure contact with the positive electrode terminal and negative electrode terminal. However, since connection is only effected with the terminals by bending of the tip of the current collecting element in an acute-angled shape within the elastic range, by the elastic restoring force thereof, the electrical connection is unstable and the problem is experienced of a lack of stability of the battery's output under conditions of use in which it is subjected to vibration.

[0009]

In view of the above problems of the prior art, an object of the present invention is to provide a rechargeable battery wherein the efficiency of current collection is high, the rise in temperature during charging/discharging can be reduced, and in which charging/discharging can be achieved in a stable fashion with an inexpensive construction.

[0010]

[MEANS FOR SOLVING THE PROBLEMS]

In a rechargeable battery according to the present invention, in which an electrode group obtained by superimposing a positive electrode plate, in which positive electrode material is attached to a positive electrode current collecting element, and a negative electrode plate, in which negative electrode material is attached to a negative electrode current collecting element, with a

separator therebetween is accommodated in a battery enclosure together with electrolyte, the current collecting element of one of the electrode plates is made to project on at least one side of the electrode plate group, and current collecting plates are joined to flat sections formed at the tip of these projections by the projections themselves. Since the current collecting plates are joined to flat sections formed on one side of the current collecting elements, the current collection efficiency is high and the rise in temperature during charging/discharging can be kept small. Furthermore, since the flat sections are formed by the current collecting elements themselves, the construction can be made inexpensive and the construction is stable with respect to vibration etc since these current collecting plates are joined to these flat sections, so charging and discharging can be effected in a stable fashion.

[0011]

If an electrode plate group is provided in which the positive electrode plate and negative electrode plate are wound in spiral fashion with a separator therebetween, with current collecting elements of both electrode plates respectively projecting at both ends thereof, and flat sections are formed by pressing the ends of the electrode plate group in the direction of the winding axis core, formation can be effected in a efficient fashion by pressing

the flat sections of the current collecting elements for joining the current collecting plates.

[0012]

If the current collecting plates are arranged so as to make contact with the flat sections, and are laser-welded in the radial direction at a plurality of locations in the circumferential direction, a large number of locations of the side edges of the current collecting elements can be integrally welded in a simple fashion to the current collecting plates, making it possible to achieve high current collection efficiency with an easy operation.

[0013]

If ribs are provided that project towards the projections of the current collecting elements on the current collecting plates and the flat sections of the current collecting elements are formed by pressing ribs thereupon and welding the current collecting elements and the current collecting plates at the ribs, reliable contact between the current collecting plates and flat sections can be achieved at the ribs, and a more reliable joined condition of the current collecting plates and current collecting elements can be obtained.

[0014]

[EMBODIMENTS OF THE INVENTION]

A lithium ion rechargeable battery according to an embodiment of the rechargeable battery of the present invention is described below with reference to Figure 1 to Figure 3.

[0015]

In Figure 1, 1 is a positive electrode plate and 2 is a negative electrode plate; an electrode plate group 10 is constituted by winding in spiral fashion positive electrode plate 1 and negative electrode plate 2 in a mutually opposed condition with a separator 3 made of microporous polyethylene film therebetween; this electrode plate group 10 is accommodated and arranged within battery enclosure 4 together with electrolyte. Battery enclosure 4 comprises a battery case 5 which is of cylindrical enclosure shape and constitutes an negative electrode terminal and a battery cover 6 constituting a positive electrode terminal; battery enclosure 4 is sealed and mutual insulation is effected by means of insulating packing 7 interposed between the inner circumference of the top aperture of battery case 5 and the outer circumference of battery cover 6. Separator 3 is interposed between electrode plate group 10 and the inner circumference of battery case 5.

[0016]

Positive electrode plate 1 is constituted by coating both surfaces of positive electrode current collecting

element 1b with positive electrode material 1a; a side part (in the example illustrated, the top part) of this positive electrode current collecting element 1b projects from the portion that is coated with positive electrode material 1a. Also, negative electrode plate 2 is constituted by coating both surfaces of negative electrode current collecting element 2b with negative electrode material 2a; the other side part (in the example illustrated, the bottom part) of this negative electrode current collecting element 2b projects from the portion that is coated with negative electrode material 2a. Separator 3 projects to the outside beyond both side edges of the coated portions of positive electrode plate 1 and negative electrode plate 2.

[0017]

A flat section 11 is formed by plastic deformation of the projection of positive electrode current collecting element 1b by pressing the portion of positive electrode current collecting element 1b that projects beyond separator 3, and positive electrode current collecting plate 8 is joined to this flat section 11. Likewise, a flat section 12 is formed by plastic deformation of the projection of negative electrode current collecting element 2b by pressing the portion of negative electrode current collecting element 2b that projects beyond separator 3, and negative electrode current collecting plate 9 is joined to this flat section 12.

This positive electrode current collecting plate 8 and negative electrode current collecting plate 9 are respectively connected to battery cover 6 and battery case 5. 8a and 9a are connecting strips extending from the outer circumference for connecting the current collecting plates 8 and 9 to the inside surface of battery cover 6 and the inside bottom surface of battery case 5.

[0018]

A detailed description of positive electrode plate 1, negative electrode plate 2 and the electrolyte will now be given. Positive electrode current collecting element 1b is made of aluminum foil or the like and positive electrode plate 1 is constituted by coating both surfaces thereof with positive electrode material 1a containing positive electrode active substance and a binding agent. The positive electrode active substance employed is $LiCoO_2$, $LiMn_2O_4$, $LiNiO_2$, a product in which some of this Co, Mn or Ni is substituted with another transition metal, or a lithium-containing transition metal oxide other than these. In particular, Mn-based lithium-containing transition metal oxides such as the globally abundant low-cost $LiMn_2O_4$ are suitable.

[0019]

Negative electrode current collecting element 2b is made of copper foil or the like and negative electrode plate 2 is constituted by coating both surfaces thereof with negative

electrode material 2a containing negative electrode active substance and a binding agent. The negative electrode active substances employed may be carbon-based materials such as graphite, petroleum coke, carbon fiber, or organic polymer sintered products, or there may be employed metals or oxides capable of occluding and releasing lithium, or composite materials of these.

[0020]

Also, as the electrolyte, it is possible to employ electrolytes obtained by dissolving as solute a lithium salt such as lithium hexafluorophosphate ($LiPF_6$), lithium perchlorate ($LiClO_4$), or lithium fluoroborate ($LiBF_4$) using a non-aqueous solvent such as ethylene carbonate (EC), propylene carbonate (PC), diethylene carbonate (DC) or ethylene methyl carbonate (EMC) as solvent, either alone or as a mixed solvent of these, in a concentration of solute of 0.5 mol/dm^3 to 2 mol/dm^3 in the solvent.

[0021]

To give a specific example, positive electrode material 1a was produced by mixing in a respective weight ratio of 92:3:5 $LiMn_2O_4$ manufactured by mixing electrolyzed manganese dioxide (EMD: MnO_2) and lithium carbonate (Li_2CO_3) with a ratio Li/Mn= 1/2 and sintering in the atmosphere for 20 hours at 800°C, acetylene black serving as conducting agent and polyfluorovinylidene as binding agent. As the

polyfluorovinylidene binding agent used for kneading the positive electrode material 1a into paste form, N-methylpyrrolidone dispersion was employed. The mixing ratios given above are ratios in terms of the solid fractions. The positive electrode material layer was formed by coating both faces of the positive electrode current collecting element 1b made of 20 μm thick aluminum foil with this positive electrode material paste in a condition leaving a region of width 10 mm on one side edge as an uncoated region. The film thickness of both positive electrode material layers was the same and the sum of the two film thicknesses after coating and drying was 280 μm, giving a positive electrode plate thickness of 300 μm. After this, compressive forming was conducted using a press roll of diameter 300 mm to produce a thickness of the positive electrode plate 1 of 200 μm. The density of the positive electrode material was then 3.0 g/cm^3.

[0022]

For the negative electrode material 2a, a mixture of artificial graphite and styrene butadiene rubber (SBR) as binding agent in a weight ratio of 97:3 was employed. In order to knead the negative electrode material 2a into the form of a paste, the styrene butadiene rubber binding agent was employed in the form of an aqueous dispersion. The above mixing ratios are expressed as solid fractions. The negative electrode material layer was formed by coating both faces of

the negative electrode current collecting element 2b made of 14μm thick copper foil with this negative electrode material paste in a condition leaving a region of width 10 mm on one side edge as an uncoated region. After this, compressive forming was conducted using a press roll of diameter 300 mm to produce a thickness of the negative electrode plate 2 of 170 μm. The density of the negative electrode material was then 1.4 g/cm^3.

[0023]

As the electrolyte, an electrolyte was employed obtained by dissolving lithium hexafluorophosphate ($LiPF_6$) as solute in a concentration of 1 mol/dm^3 in a mixed solution obtained by mixing ethylene carbonate (EC) and diethylene carbonate (DEC) in a volume blending ratio of 1:1.

[0024]

In the manufacturing of such a lithium ion rechargeable battery, an electrode plate group 10 is formed by winding in spiral fashion positive electrode plate 1 and negative electrode plate 2 manufactured as above facing each other with a separator 3 in between and with the uncoated regions of these current collecting elements 1b, 2b projecting at both ends. As shown in Figure 2, this electrode plate group 10 is inserted and arranged in a molding jig 13 of cylindrical enclosure shape, and is subjected to pressure by a pressing implement 14 from one end aperture of molding jig

13. When this is done, flat sections 11, 12 are formed by plastic deformation of the projections of current collecting elements 1b, 2b so that they are bent by about 90° radially inwards as shown by the imaginary lines. Specifically, since positive electrode plate 1 and negative electrode plate 2 are wound in spiral fashion, the projections of current collecting elements 1b, 2b, instead of being bent radially outwards, are subjected to plastic deformation so that they are, overall, bent progressively radially inwards in practically uniform manner so that, although some degree of folding occurs, they are as a whole formed into flat sections 11, 12.

[0025]

Next, the electrode plate group 10 formed with flat sections 11, 12 is removed from molding jig 13 and, as shown in Figure 3, the current collecting plates 8, 9 and flat sections 11,12 are laser welded by irradiating a plurality of locations in the circumferential direction of the surfaces of the current collecting plates 8, 9 with a laser beam 15 in radial fashion from the middle towards the outer periphery, in a condition with both of these pressed into contact with each other by arranging the current collecting plates 8, 9 so as to press against flat sections 11, 12. After this, the electrode plate group 10 with these current collecting plates 8, 9 joined to it is vacuum impregnated by accommodating it

within battery case 5 together with the electrolyte and is sealed therein by battery cover 6 and current collecting plates 8, 9, battery cover 6 and battery case 5 are respectively connected by laser welding etc.

[0026]

With a lithium ion rechargeable battery constructed as above, since electrode plate group 10 is provided by winding in spiral fashion a positive electrode plate 1 and negative electrode plate 2 with a separator 3 therebetween with current collecting elements 1b, 2b of the two electrode plates respectively projecting at both ends thereof and the current collecting plates 8, 9 are joined to the flat sections 11, 12 formed on the projections of the current collecting elements 1b, 2b, the efficiency of current collection is high and the rise in temperature during charging/discharging can be kept small. Furthermore, since the flat sections 11, 12 are formed by the current collecting elements 1b, 2b themselves, the construction can be made of low cost and the construction is stable with respect to vibration etc since these flat sections 11, 12 are joined to current collecting plates 8, 9, so charging and discharging can be effected in a stable fashion.

[0027]

Also, since flat sections 11, 12 are formed by applying pressure to both ends of the electrode plate group 10 in the

direction of the core of the winding axis, the flat sections 11, 12 for joining the current collecting plates 8, 9 can be formed in an efficient fashion.

[0028]

Also, since current collecting plates 8, 9 are pressed towards flat sections 11, 12 and subjected to laser welding in the radial direction at a plurality of locations in the circumferential direction in this pressed-together condition, integral welding of a large number of locations of the side edges of current collecting elements 1b, 2b to the current collecting plates 8, 9 can be achieved in a straightforward fashion, enabling high current collection efficiency to be achieved with ease of operation.

[0029]

Although, in the description of the above embodiment, the case was illustrated, by way of example, in which the entire surface of the current collecting plates 8, 9 was of flat plate shape, it would be possible, as shown in Figure 4, for ribs 16 that project towards the projections of current collecting elements 1b, 2b of electrode plate group 10 to be formed projecting in radial fashion on current collecting plates 8, 9, laser welding being effected along ribs 16 in a condition with flat sections 11, 12 formed, current collecting plates 8, 9 being subjected to pressure such that

these ribs 16 bite into the projections of current collecting elements 1b, 2b.

[0030]

By providing ribs 16 in this way on current collecting plates 8, 9, when laser welding is conducted with these pressed against the projections of current collecting elements 1b, 2b, the flat sections 11, 12 formed on the projections reliably make contact with the current collecting plates 8, 9 through ribs 16, enabling a more reliable joining condition of current collecting plates 8, 9 and current collecting elements 1 b, 2 b to be obtained.

[0031]

[BENEFITS OF THE INVENTION]

As will be clear from the above description, with the rechargeable battery of the present invention, since joining with the current collecting plate is achieved by the current collecting element of one or other of the electrodes projecting on at least one side of the electrode plate group, a flat section being formed at the tip of the projection by the projection itself, current collection efficiency is high and the rise in temperature during charging/discharging can be made small; also, since the flat section is formed by the current collecting element itself, an inexpensive construction can be achieved and since the current collecting plate is joined to the flat section the construction is

stable with regard to vibration etc. This therefore makes it possible to achieve stable charging/discharging and is useful in realizing high current collection efficiency and stable charging/discharging with an inexpensive construction.

[0032]

If the positive electrode plate and negative electrode plate are wound in spiral fashion with the separator therebetween, with current collecting elements of both electrode plates respectively projecting at both ends thereof, and flat sections are formed by pressing the ends of the electrode plate group in the direction of the winding axis core, formation can be effected in a efficient fashion by pressing the flat sections of the current collecting elements for joining the current collecting plates.

[0033]

If the current collecting plates are arranged so as to make contact with the flat sections, and are laser-welded in the radial direction at a plurality of locations in the circumferential direction, a large number of locations of the side edges of the current collecting elements can be integrally welded in a simple fashion to the current collecting plates, making it possible to achieve high current collection efficiency with an easy operation.

[0034]

If ribs are provided that project towards the projections of the current collecting elements on the current collecting plates and the flat sections of the current collecting elements are formed by pressing ribs thereupon and welding the current collecting elements and the current collecting plates at the ribs, reliable contact between the current collecting plates and flat sections can be achieved at the ribs, and a more reliable joined condition of the current collecting plates and current collecting elements can be obtained.

[BRIEF DESCRIPTION OF THE DRAWINGS]

Figure 1 is an axial cross-sectional view of an embodiment of a rechargeable battery according to the present invention;

Figure 2 is an axial cross-sectional view of a step wherein a flat section is formed on a projection of a current collecting element of an electrode plate group in this embodiment;

Figure 3 is a perspective view of a step in which the current collecting plate is joined to the flat section of the current collecting element of the electrode plate group in this embodiment;

Figure 4 is a perspective view illustrating the current collecting plate and the joined condition thereof in a

further embodiment of a rechargeable battery according to the present invention; and

Figure 5 is an axial cross-sectional view of a rechargeable battery according to an example of the prior art.

[DESCRIPTION OF THE REFERENCE NUMERALS]

1 positive electrode plate

1a positive electrode material

1b positive electrode current collector

2 negative electrode plate

2a negative electrode material

2b negative electrode current collector

3 separator

4 battery container

8 positive electrode current collector plate

9 negative electrode current collector plate

10 electrode plate group

11 flat plane

12 flat plane

13 molding jig

14 press member

15 laser beam

16 rib

[DOCUMENT] ABSTRACT

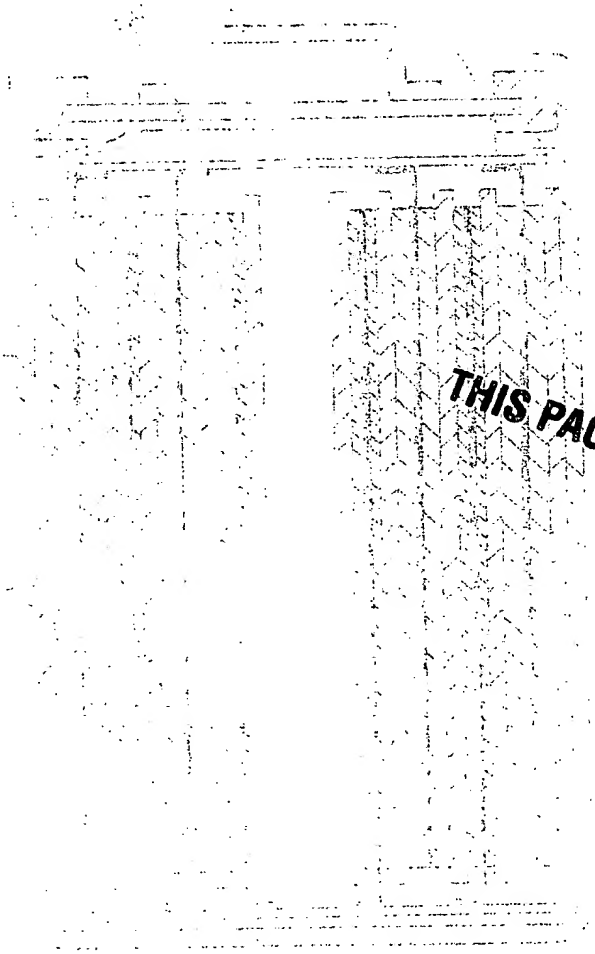
[ABSTRACT]

[OBJECT] To provide a rechargeable battery of an inexpensive structure, which exhibits high current collecting efficiency and stable charging/discharging characteristics, and with which the rise in temperature during charging/discharging can be made small.

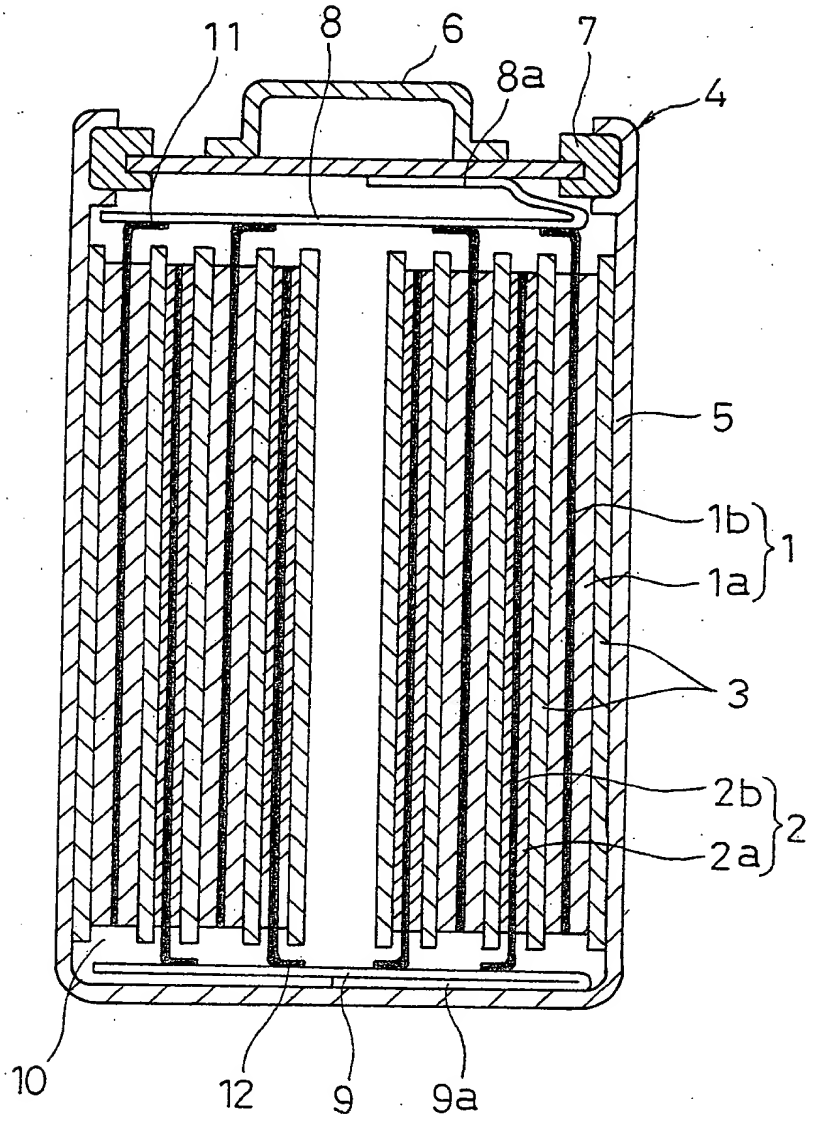
[MEANS FOR SOLUTION]

In a rechargeable battery in which an electrode group 10 obtained by superimposing a positive electrode plate 1, in which positive electrode material 1a is attached to a positive electrode current collecting element 1b, and a negative electrode plate 2, in which negative electrode material 2a is attached to a negative electrode current collecting element 2b, with a separator 3 therebetween is accommodated in a battery enclosure 4 together with electrolyte, the current collecting elements 1b, 2b of the electrode plates 1, 2 are respectively made to project at both ends of the electrode plate group 10, and current collecting plates 8, 9 are joined to flat sections 11, 12 formed by current collecting elements 1b, 2b themselves by pressing these projections.

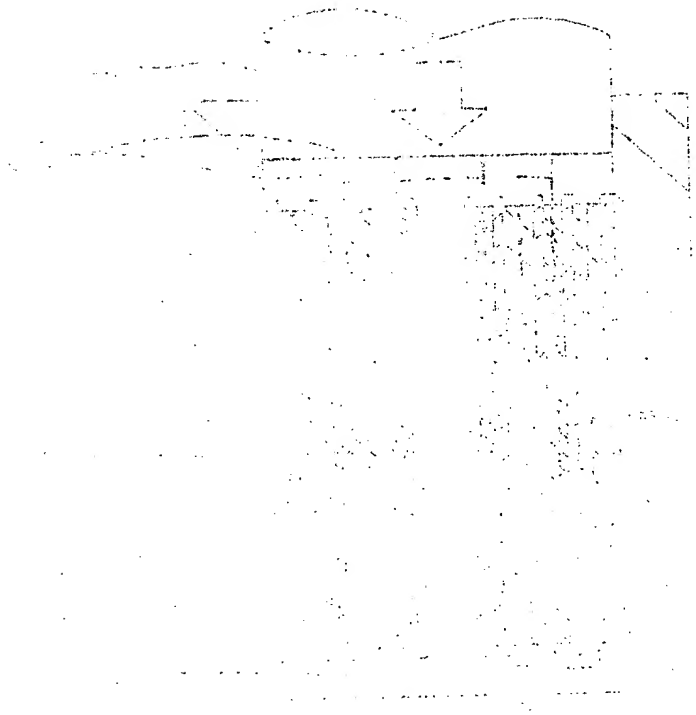
[SELECTED DRAWING] Figure 2

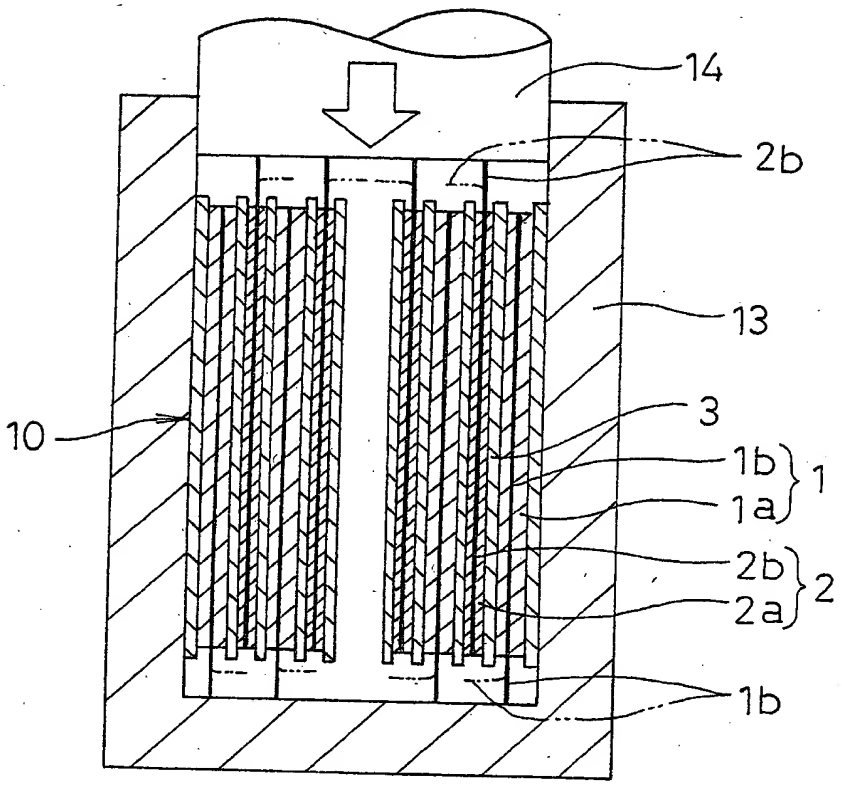


[Document] Drawing
[Fig. 1]



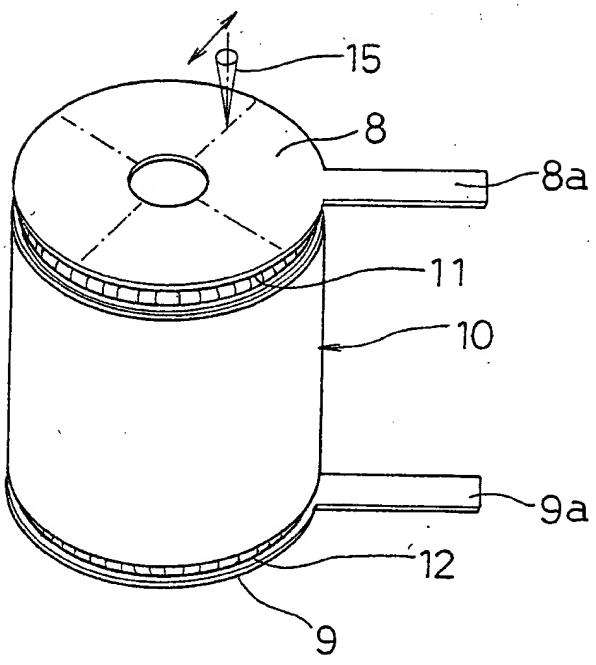
1	positive electrode plate
1a	positive electrode material
1b	positive electrode current collector
2	negative electrode plate
2a	negative electrode material
2b	negative electrode current collector
3	separator
4	battery container
8	positive electrode current collector plate
9	negative electrode current collector plate
10	electrode plate group
11	flat plane
12	flat plane



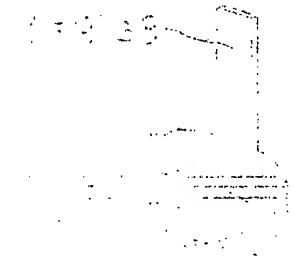


13 molding jig
14 press member

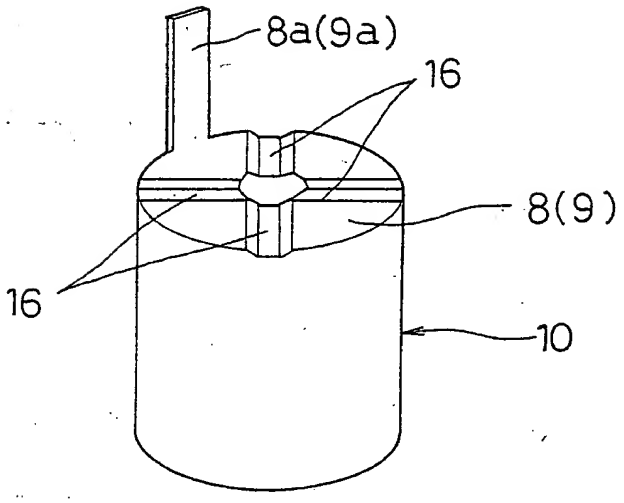
[Fig. 3]



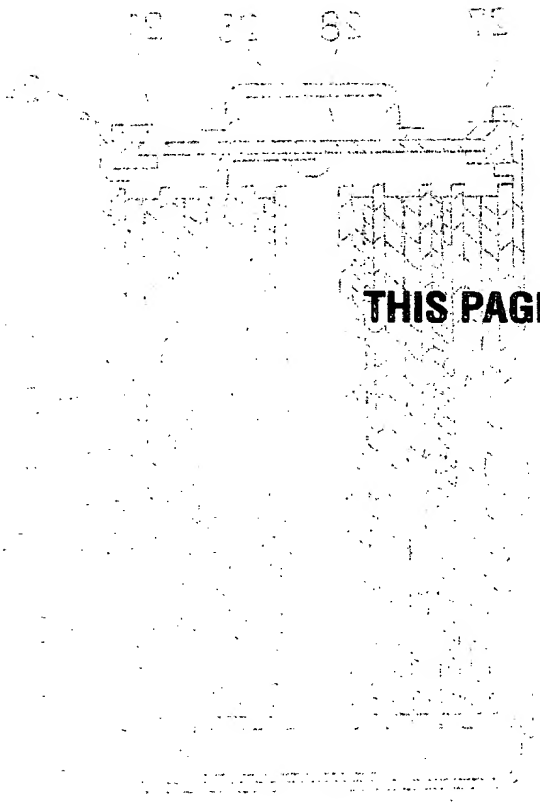
15 laser beam



[Fig. 4]



16 rib



[Fig. 5]